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N
Wayne Hartwick

April 15, 1993

VIA MESSENGER

Steve Siegel, Esq.
Assistant Regional Counsel (5CS TUB-3)
United States Environmental Protection Agency
111 West Jackson
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Chicago, Illinois 60604

OFFICE OF SUPERFUND
ASSOCIATE
DIVISION DIRECTOR

RECEIVED
APR 20 1993

Re: American Chemical Service CERCLA Site -- Griffith,
Indiana
Our File #10007-63001

Dear Steve:

As Chairman of the American Chemical Services PRP Group, I am writing to formally transmit to USEPA analyses of the treatability studies conducted by the American Chemical Services PRP Group's consultant, Warzyn, Inc., referred to in my January 13 letter to you. A copy of Warzyn's report as transmitted to Mr. Wayne Hartwick is attached. Treatability studies were initiated by the PRP Group to evaluate the remedy selected in the ROD, and in particular its ability to achieve the clean-up levels specified in the ROD. They were conducted at a cost of more than \$200,000, and evaluated the capabilities of soil vapor extraction (SVE), low temperature thermal treatment (LTTT) and bioventing enhanced SVE to reduce contaminants present in the subsurface of the ACS site to the clean-up levels selected by USEPA.

While the results of the treatability studies are discussed in far more detail in Warzyn's analysis and the consultants' reports, in sum, Warzyn finds that LTTT is the only remedial technology which will achieve all of the Agency's selected clean-up levels for VOCs, PCBs and SVOCs [and even then demonstration of the ability of LTTT to reduce SVOCs to the selected clean-up levels is not possible insofar as the analytical detection limits for SVOCs are higher than the Agency's selected clean-up levels]. The treatability studies also demonstrate that SVE should achieve the ROD-selected VOC clean-up levels. SVE (either alone or biologically-enhanced) will not achieve some of the SVOC

Steve Siegel, Esq.

April 15, 1993

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clean up criteria specified in the ROD. However, it will reduce SVOC concentrations to alternate clean-up levels protective of human health and the environment (using USEPA's own risk-assessment guidance).

We have transmitted this information to Mr. Hartwick with the expectation that the results of the treatability studies and Warzyn's analysis of those results will be extremely important to USEPA in developing a work plan for the RD/RA, and in reassessing whether the clean-up levels selected in the ROD are appropriate given the technologies to be employed at the Site. Copies of Warzyn's report are also being submitted to you, together with this letter, to express the importance of the ramifications of this new information.

The ACS PRP Group believes that USEPA should take all necessary steps to provide Mr. Hartwick and the Agency's technical staff with the time necessary to review the studies and Warzyn's analysis, and to ensure that USEPA's technical staff confer with USEPA's enforcement branch to determine the manner in which this information impacts the assumptions which underlie the ROD. Indeed, special notice letters should not issue until USEPA makes this internal determination and discusses it with the PRPs.

The ACS PRP Group believes that the submitted information also is extremely important to the prospect of voluntary remediation at ACS insofar as it clearly demonstrates that EPA's assumptions regarding the ability of SVE to effectuate soil clean up for SVOCs to the levels specified in the ROD are erroneous. On the other hand, the risk analysis information which has been made available to the Agency by the PRP Group's consultants, Dr. Frank Mink, Conestoga Rovers & Associates, and Warzyn, on December 16, 1992, and by letter of February 10, 1993, (copy attached) demonstrates that soil clean-up levels for SVOCs can be established so that SVE can be utilized for the contaminated soils, without any increased risk to human health or to the environment, when the risk is evaluated using the most recent USEPA guidance (guidance which was available at the time EPA developed its clean up standards without benefit of public comment and inserted them into the ROD).

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Failure to fully evaluate the information being provided is obvious: LTTT will have to be utilized for the entire ACS Site, approximately doubling the cost of remedy to over \$80,000,000.00 without any additional protection of human health and the environment. As you must know, USEPA's arbitrary insistence on a remedial approach costing twice as much but which would result in no risk reduction benefit would not be defensible as cost effective. This would seriously jeopardize the organization of a PRP group to voluntarily undertake the remedy.

We trust that USEPA will agree with our assessment of the significance and import of this new information, and will take all steps necessary to thoroughly review the bench scale results and risk data and evaluate its implications respecting development of a successful RD/RA before issuing special notice letters. Clearly, USEPA's own initial review and evaluation is a prerequisite to the implementation of a sound mutual approach which the PRPs hope can be developed and set forth in the RD/RA Statement of Work and Work Plan.

Very truly yours,

Andrew H. Perellis

AHP:cc
ahp0414

cc: Valdas Adamkus, Regional Administrator, USEPA, Region V (w/o studies)
William Muno, Director, Waste Management Division, USEPA, Region V (w/o studies)
Gail Ginsberg, Regional Counsel, USEPA, Region V (w/o studies)
Wayde Hartwick, Waste Management Division, USEPA, (w/o studies)
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Ronald Frehner
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April 8, 1993

Mr. Wayde M. Hartwick
United States Environmental Protection Agency
Region V, HSRL-6J
77 West Jackson Boulevard
Chicago, Illinois 60604

Re: Transmittal of Treatability Study Reports
American Chemical Services (ACS) NPL Site
Griffith, Indiana

Dear Mr. Hartwick:

Enclosed are five copies of the low temperature thermal treatment (LTTT), soil vapor extraction (SVE), and bioventing bench-scale treatability study reports utilizing waste and soil samples from the American Chemical Services (ACS) site. The purpose of these bench-scale treatability studies was to evaluate the feasibility of these technologies to successfully treat the waste and contaminated soil matrices at the ACS site, and evaluate the potential for these technologies to achieve the clean-up levels listed in the Record of Decision (remediation levels) for the ACS site.

These treatability study reports show that the technologies can successfully from a bench-scale perspective treat the ACS waste and contaminated soil matrices as was expected based the ACS Feasibility Study report. LTTT typically achieved >99.9% removal of volatile organic compounds (VOCs) from the waste samples used in the treatability study. The SVOC removals ranged from >77.2% to >99.9%. Polychlorinated biphenyls (PCB) removals ranged from >98.6% to >99.3%.

The removals of total VOCs from the contaminated soil samples using SVE ranged from 99.3% to > 99.9%, but total SVOC removal was approximately 52 %. Bioventing with nutrient amendments improved the SVOC removals to between 61.5% and 88.5%. The VOC removals for bioventing ranged up to >99.9%. A more detailed summary of the treatability studies is included with this letter as Attachment A.

The LTTT treatability study results for the waste matrix indicate that the remediation levels for VOCs and PCBs were achieved, while SVOCs were reduced to the analytical detection limits. Based upon the LTTT treatability study results, however, it is not possible to prove that all of the remediation levels for SVOCs were achieved due to matrix interferences limiting the sensitivity of the methodology. The results of the SVE and bioventing treatability studies for the

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contaminated soil samples indicate that the remediation levels for VOCs were achieved.

Based upon the SVE treatability study results, reductions in SVOC concentrations were realized. However, SVOC remediation levels were not achieved in those instances where the initial concentrations exceeded their respective remediation levels. It is not possible to prove that many of the SVOC remediation levels were achieved using bioventing or SVE due to matrix interferences limiting the sensitivity of the methodology. The analytical method detection limits utilized were consistent with the United States Environmental Protection Agency Contract Laboratory Protocol, but there were also matrix interferences due to the concentration of organic material remaining in the treated samples which elevated the detection limits. Analytical detection limits will be an issue at full scale implementation of these technologies.

Warzyn and Conestoga-Rovers & Associates (CRA) are convinced that LTTT of the waste matrix and SVE/bioventing for the contaminated soil matrix are the appropriate technologies, but believe that due to uncertainties in scale-up, the complex nature of the matrices and high levels of contaminants at the site, it may not be possible to achieve or demonstrate achievement of each of the individual remediation levels. Warzyn and CRA have previously questioned the methodology used to set the remediation levels. Unless adjustments are made to certain remediation levels, or a technical infeasibility waiver is granted, where appropriate, as part of the CERCLA review process, the remediation technologies selected in the ROD, which appear well suited to address the site contaminants based on the treatability study results, will not meet each of the prescribed cleanup criteria.

Warzyn and CRA look forward to meeting with you later this month to discuss the results of the treatability study and your thoughts on our request to modify the approach to the calculations of the remediation levels.

Sincerely,

WARZYN INC.

Martin J. Hamper
Project Manager

Mark S. Rothas
Senior Project Engineer

Enclosures: Attachment A
LTTT Treatability Report (5)
SVE Treatability Report (5)
Bioventing Treatability Report (5)

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TABLE 1
SUMMARY OF BENCH SCALE PERFORMANCE - CANONIE LTTT
OFF-SITE CONTAINMENT AREA

PARAMETER	INITIAL (MG/KG)	TREATED (MG/KG)	ROD REMEDICATION LEVEL (MG/KG)
<u>VOCs</u>			
ACETONE	110	0.19	80
METHYLENE CHLORIDE	1,500	0.29	6.2
1,1 DICHLOROETHENE	30	0.0064	0.098
1,1 DICHLOROETHANE	100	ND (0.005)	77
CHLOROFORM	43	0.0036	9.5
1,2 DICHLOROETHANE	3,200	0.0084	0.64
2-BUTANONE	560	ND (0.1)	21
1,1,1 TRICHLOROETHANE	1,300	0.044	77
1,2 DICHLOROPROPANE	27	ND (0.005)	0.42
TRANS-1,3-DICHLOROPROPENE	25	ND (0.005)	
1,1,1,2-TETRACHLOROETHANE	3,700	0.03	5.3
DIBROMOCHLOROMETHANE	28	ND (0.005)	
BENZENE	490	0.023	1
CIS-1,3-DICHLOROPROPENE	22	ND (0.005)	
BROMOFORM	28	ND (0.005)	
TETRACHLOROETHENE	1,400	0.048	1.1
TOLUENE	2,200	0.034	167
CHLOROBENZENE	67	0.026	5
ETHYLBENZENE	870	0.027	43
STYRENE	420	0.014	1.7
XYLENES, TOTAL	3,700	ND (0.005)	867
<u>PCBs</u>			
AROCHLOR 1254	77	ND (1)	2
<u>VOCs</u>			
PHENOL	150	ND (0.33)	
2-METHYLPHENOL	10	ND (0.33)	
4-METHYLPHENOL	21	ND (0.33)	
ISOPHORONE	150	ND (0.33)	7.2
2,4-DIMETHYLPHENOL	10	ND (0.33)	
NAPHTHALENE	100	ND (0.33)	3
HEXACHLOROBUTADIENE	17	ND (0.33)	0.36
2-METHYLNAPHTHALENE	64	ND (0.33)	
DIMETHYL PHTHALATE	12	ND (0.33)	
DIETHYL PHTHALATE	6.6	ND (0.33)	
PHENANTHRENE	3.3	ND (0.33)	
DI-N-BUTYL PHTHALATE	71	ND (0.33)	77
BUTYLBENZYL PHTHALATE	51	ND (0.33)	
BIS(2-ETHYLHEXYL)PHTHALATE	210	ND (0.33)	1.1

NOTE: Initial non-detects not listed

TABLE 4
SUMMARY OF BENCH SCALE PERFORMANCE - ENVIROGEN BIOVENTING
OFF-SITE CONTAINMENT AREA (nutrient amended)

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	ROD <u>REMEDIATION</u> <u>LEVEL (MG/KG)</u>
<u>VOCs</u>			
4-METHYL-2-PENTANONE	71	<9	21
TETRACHLOROTHENE	210	26	1.1
ETHYLBENZENE	580	<9	43
XYLENES TOTAL	3,280	328	867
TOLUENE	990	<9	167
<u>SVOCs</u>			
OPHORONE	130	50	7.2
NAPHTHALENE	230	140	3
BIS (2-ETHYLHEXYL) PHTHALA	610	70	1.1
DI-N-BUTYLPHTHALATE	350	55	77

NOTE: Initial non-detects not listed

TABLE 4
SUMMARY OF BENCH SCALE PERFORMANCE - ENVIROGEN BIOVENTING
OFF-SITE CONTAINMENT AREA (nutrient amended)

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDIALATION</u> <u>LEVEL (MG/KG)</u>
<u>VOCs</u>			
4-METHYL-2-PENTANONE	71	<9	21
TETRACHLOROTHENE	210	26	1.1
ETHYLBENZENE	580	<9	43
XYLENES TOTAL	3,280	328	867
TOLUENE	990	<9	167
<u>SVOCs</u>			
ISOPHORONE	130	50	7.2
NAPHTHALENE	230	140	3
BIS (2-ETHYLHEXYL) PHTHALATE	610	70	1.1
DI-N-BUTYLPHTHALATE	350	55	77

NOTE: Initial non-detects not listed

TABLE 5
SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE
TREATMENT LAGOON AREA (low air flowrate)

<u>Parameter</u>	INITIAL <u>(MG/KG)</u>	TREATED <u>(MG/KG)</u>	ROD REMEDICATION <u>LEVEL (MG/KG)</u>
<u>VOCs</u>			
ACETONE	37	<0.028	80
2-BUTANONE	20	<0.028	21
1,1,1-TRICHLOROETHANE	18	<0.028	77
4-METHYL-2-PENTANONE	40	<0.028	21
TOLUENE	86	<0.028	167
TETRACHLOROETHENE	18	<0.028	1.1
ETHYLBENZENE	56	0.044	43
TOTAL XYLENE	262	0.43	867

TE: Initial non-detects not listed

TABLE 6
SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE
TREATMENT LAGOON AREA

PARAMETER	INITIAL (MG/KG)	TREATED REMEDIATION (MG/KG) LEVEL	ROD (MG/KG)	WARZYN RESIDENTIAL STD. (MG/KG)	WARZYN INDUSTRIAL STD. (MG/KG)
<u>VOCs</u>					
ACETONE	27	<0.006	80	RLT	RLT
2-BUTANONE	23	<0.006	21	NA	NA
1,1,1-TRICHLOROETHANE	40	<0.006	77		NA
TRICHLOROETHENE	14	<0.006	5.3	191	408
4-METHYL-2-PENTANONE	48	<0.006	21	NA	RLT
TOLUENE	140	<0.006	167	RLT	RLT
TETRACHLOROETHENE	30	<0.006	1.1	41	157
ETHYLBENZENE	86	<0.006	43	RLT	RLT
TOTAL XYLENE	420	<0.006	867	RLT	RLT

SVOCs

BIS (2-CHLOROETHYL)ETHER	2	<0.4	0.027	2	8
ISOPHORONE	23	9.6	7.2	536	2,179
NAPHTHALENE	10	0.6	3	RLT	RLT
HEXACHLOROBUTADIENE	2	2	0.36	28	110
PENTACHLOROPHENOL	<0.9	5.4	0.43	19	81
BIS (2-ETHYLHEXYL)PHTHALATE	76	35	1.1	144	537
DI-N-BUTYLPHTHALATE	15	8.8	77	RLT	RLT

NOTE: Initial non-detects not listed

RLT= Relatively low toxicity

TABLE 7
SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE
OFF-SITE CONTAINMENT AREA

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDIATION</u> <u>LEVEL (MG/KG)</u>
<u>VOCs</u>			
1,1,1-TRICHLOROETHANE	57	<0.78	77
4-METHYL-2-PENTANONE	62	<0.78	21
TOLUENE	1,200	1.6	167
TETRACHLOROETHENE	220	<0.78	1.1
ETHYLBENZENE	440	3.4	43
TOTAL XYLENE	2,490	26	867

TE: Initial non-detects not listed

A

SUMMARY OF TREATABILITY STUDY RESULTS AMERICAN CHEMICAL SERVICES SITE

LTTT TREATABILITY STUDY

A low temperature thermal treatment (LTTT) treatability study was performed by Canonie Environmental Services Corp. (Canonie) on three waste samples from the American Chemical Services (ACS) site. The three samples included two from the Off-Site Containment Area and one from the On-Site Containment Area. The On-Site Containment Area sample and one Off-Site Containment Area sample were spiked with selected contaminants in order to achieve higher concentrations considered to be more representative of reasonable worst case levels based on the RI data. The Canonie treatability study system operated at a maximum temperature of 1100°F and a residence time of 30 minutes. The treatability study samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs) before and after treatment. The following summarizes the results of the LTTT treatability study (Tables 1-7).

- The LTTT treatability study results demonstrated that the ACS buried waste can potentially be treated to the greater of the remediation levels or the analytical detection limits under the optimum conditions that exist at the bench-scale. Residual non-volatile organic material is expected to remain in the treated waste at percentage levels based on the total organic carbon (TOC) results for the coked solids.
- For all three test runs, significant removal efficiencies were achieved for VOCs, SVOCs, and PCBs. For compounds with initial concentrations in excess of site remediation levels, the final concentrations were reduced to below the greater of the remediation level or the analytical detection limit. However, residual levels of VOCs were detected in the

treated waste samples. Low parts per billion concentrations of several VOCs were detected in the treated waste for one of the test runs. Two to three VOCs were detected in the treated waste for the other two test runs, but the detection limits were elevated. SVOCs and PCBs were below analytical detection limits in the treated waste for all three test runs.

- The initial concentrations and types of VOCs, SVOCs, and PCBs are considered representative for the On- and Off-Site Areas. The addition of the spiking solution to two of the test samples was designed to simulate a waste matrix for treatability study purposes. Because of the reasons discussed in the Canonic report, the spiking concentrations were not reflected in the initial concentrations based on the analytical data. It is believed that the treatability tests for the two spiked samples were representative of reasonable worst case concentrations for the waste matrix, even though the analytical data cannot be used to support this presumption.
- The analytical detection limits exceeded the remediation levels in two of the test runs for the VOCs vinyl chloride, carbon tetrachloride, and 1,1,2,2-tetrachloroethane and in all three test runs for the SVOCs bis(2-chloroethyl) ether, hexachlorobutadiene, 2,4- and 2,6-dinitrotoluene, hexachlorobenzene, pentachlorophenol, and carcinogenic polynuclear aromatic hydrocarbons (PAHs). The analytical detection limits were either consistent with the United States Environmental Protection Agency Contract Laboratory Program Method Detection Limits (CLP), or due to matrix interferences caused by residual high boiling point organic materials remaining in the waste following treatment.
- Residual non-volatile organic material remained in the treated waste based on the total organic carbon (TOC) results for the coked solids and matrix interferences observed during the VOC and SVOC analytical testing.

The following factors associated with the effectiveness and operation of a full-scale LTTT system were not evaluated as part of a bench-scale treatability study. These conditions will be evaluated during the Remedial Design and Remedial Action (RD/RA) phases of this project.

- The treatability study results may not be applicable to worst case maximum concentrations in the waste matrix that could be encountered if excavated material is not adequately homogenized prior to treatment. It is believed that the unspiked composite waste sample can be considered representative of weighted average contaminant

concentrations (i.e., concentrations following blending of the excavated soil) in the defined waste areas for the locations and depths sampled in the Off-Site Containment Area, which were significantly lower than the maximum concentrations for individual contaminants measured during the ACS Remedial Investigation (RI). The spiked samples are believed to be representative of the waste matrix (minus absorption effects).

- Because of the composition of the waste matrix, potential material handling problems will likely have to be addressed during the design phase. The "tackiness" of the sludge matrix, as well as the presence of free liquids, could pose volatilization, blending, handling, and conveyance problems during full-scale operation. The presence of sludge and free liquids was noted in the treatability study samples during sampling and analysis activities (e.g., one sample separated into distinct liquid and solid phases which could not be blended together during the analysis of initial concentrations).
- Depending on the design of a specific LTTT system, volatilized organics can either be treated in the air phase or condensed for off-site treatment or disposal. The economics of treating or disposing of a condensed residual wastestream versus operation of an air treatment system will have to be weighed during the design phase prior to selecting a full-scale LTTT system. The Canonic treatability study system condensed the volatilized organics for collection and off-site treatment. This data can be used in future economic evaluations of LTTT system operation.
- LTTT units are typically designed to handle TOC levels of 1% to 10%. The Canonic system is reportedly capable of treating up to 10% TOC. Because of the high TOC levels in the waste matrix across the site, which were reflected in the treatability study samples, soil blending will likely be required to treat the waste matrix at the Site.
- The high moisture levels in the treatability study samples (18.6 to 29.2%) believed to be representative of site conditions, will likely result in slow processing rates.

SVE TREATABILITY STUDY

A soil vapor extraction bench-scale treatability study was performed by Vapex Environmental Technologies, Inc. (Vapex) on two contaminated soil samples from the ACS site. The two soil samples included one each from the Off-Site Containment and Treatment Lagoon/Still Bottoms Areas. A third soil column was run using a lower air flowrate to evaluate potential mass transfer limitations.

The laboratory soil column studies exchanged from 3,000 to 11,000 air pore volumes. The soil samples were analyzed for VOCs before and after the study. One of the three samples was also analyzed for SVOCs before and after the study. A summary of the SVE treatability study results are provided below.

- The SVE treatability study results demonstrated that the VOCs in the contaminated soil at the ACS Site can potentially be treated to the greater of the remediation levels or the analytical detection limits under the optimum conditions that exist at the bench-scale. Some SVOC removal occurred during SVE treatment without nutrient enhancement. However, the SVOCs which were initially detected in excess of their remediation levels were not reduced to below the remediation levels after treatment.
- For all three test runs, significant removal efficiencies were achieved for the VOCs. For compounds with initial concentrations in excess of site remediation levels, the final concentrations were reduced to below the greater of the remediation level or the analytical detection limit. However, residual levels of VOCs were detected in two of the treated soil samples. One test run, which had the highest initial concentrations, had low to mid parts per million concentrations of the aromatic hydrocarbons ethyl benzene, toluene, and xylene (ETX) remaining in the treated soil. The aromatic hydrocarbons were present at the highest initial concentrations of the measured VOCs, and are among the less volatile, and thus more difficult (i.e., have lower vapor pressures), of the VOCs subject to removal by SVE. Low to mid parts per billion concentrations of a few VOCs were detected in the treated soil for the low air flow rate test run. All of the measured VOCs were below the analytical detection limits for the third test run.
- Some SVOC reductions were observed based on the ending concentrations measured in the treated soil. The reduction in SVOC concentrations can be attributed either to volatilization, biological degradation, or analytical variances caused by the sampling of a potentially non-homogeneous soil matrix. However, SVOCs initially detected in excess of their respective remediation levels were not reduced to below the remediation levels after treatment. The final concentrations for isophorone, hexachlorobutadiene, pentachlorophenol, and bis(2-ethylhexyl) phthalate were above their respective remediation levels.
- Removal efficiencies for other SVOCs of interest with relatively low remediation levels, bis(2-chloroethyl) ether and carcinogenic PAHs in particular, could not be evaluated by the treatability study, because they were not detected in excess of their respective analytical detection

limits. Based on its vapor pressure, SVE removal potential for bis(2-chloroethyl) ether should be similar to naphthalene and isophorone, two compounds which were found in the treatability study samples. As was the case with isophorone, some reduction in bis(2-chloroethyl) ether would be expected to occur through volatilization and/or biological degradation. However, removal below the remediation level would not be expected to occur in areas where bis(2-chloroethyl) ether concentrations initially exceed its remediation level.

- Little to no reduction in carcinogenic PAH concentrations would be expected to occur as a result of SVE treatment based on their vapor pressures and resistance to biological degradation. Therefore, removal would not be expected to occur in areas where carcinogenic PAH concentrations initially exceed its remediation level.
- The total number of air pore volumes required to achieve greater than 90% VOC mass reduction was at the higher end of the 3,000 to 6,000 pore volume exchange range typical of bench-scale treatability studies. Tetrachloroethene would likely be a primary controlling compound for remediation purposes because of its relatively low remediation level, its high frequency of detection and initial concentrations, and lower volatility (i.e., slower removal rate by SVE). The aromatic hydrocarbons ethylbenzene, toluene, and xylene also had slower removal rates because of their lower volatility, but these compounds have higher remediation levels than tetrachloroethene.
- Other VOCs with relatively low remediation levels (e.g., carbon tetrachloride, vinyl chloride, 1,1,2-trichloroethane) were not tested, since they were not detected in the treatability study samples. It should be noted that these compounds did not have a high frequency of detection based on the RI data. Based on their vapor pressures, SVE removal potential for carbon tetrachloride, vinyl chloride, and 1,1,2-trichloroethane should be similar to trichloroethene and 1,1,1-trichloroethane, two compounds which were found in the treatability study samples. The treatability study results for trichloroethene and 1,1,1-trichloroethane demonstrate the ability of SVE treatment to potentially meet the respective remediation levels for carbon tetrachloride, vinyl chloride, and 1,1,2-trichloroethane under the optimum conditions that exist at the bench-scale.
- The initial concentrations for the VOCs and SVOCs are representative of the On-and Off-Site Areas, but are not representative of localized maximum concentrations measured during the RI.

- The analytical detection limits exceeded the remediation levels in one test run for the VOCs vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, 1,2-dichloropropane, 1,1,2-trichloroethane, and 1,1,2,2-tetrachloroethane, as well as for the SVOCs bis(2-chloroethyl) ether, 2,6- and 2,4-dinitrotoluene, hexachlorobenzene, and carcinogenic PAHs. The higher analytical detection limits were either consistent with CLP protocol, or due to matrix interferences.

The following factors associated with the effectiveness and operation of a full-scale SVE system could not be evaluated as part of a bench-scale treatability study. These conditions will be evaluated during the RD/RA phases of this project.

- Slower removal rates and higher final concentrations are usually observed for full-scale SVE systems when compared against bench-scale treatability studies. Bench-scale SVE treatability tests represent optimum, best case conditions where there is direct and continuous contact of air with the contaminants. These conditions are usually not uniformly achievable throughout the entire treatment zone for full-scale systems. Subsurface geologic heterogeneities and obstructions and mass transfer limitations usually impact the contaminant removal rates and final concentrations which are achievable for full-scale SVE systems. When these conditions exist, diffusion instead of advection (i.e., volatilization by direct contact with air) becomes the primary contaminant removal mechanism. VOC removal by diffusion mechanisms is a slower process than advection.
- The actual starting concentrations for the more water soluble contaminants may be higher at the site than what was reflected in the treatability study samples and subsequent testing. The VOCs benzene, trichloroethene, acetone, and methyl ethyl ketone and the SVOC bis(2-chloroethyl) ether were detected at lower concentrations in the treatability study samples than their respective weighted average concentrations based on the RI data. The SVE treatability study, therefore, could not test the ability to treat benzene and bis(2-chloroethyl) ether to their relatively low remediation levels.
- Each of the above mentioned compounds are among the more soluble VOCs and SVOCs in water, and likely exist to a significant extent in the soil moisture. Because the treatability study samples were prepared by compositing soil cuttings using solid flight augers, the soil moisture levels and resulting concentrations of the more soluble VOCs and SVOCs may have been lower than actual weighted average conditions. Higher concentrations of the more soluble contaminants will likely be present at depth for treatment by the full-scale SVE system.

- The high soil moisture level at the Site will likely reduce the contaminant removal rates and increase the remediation timeframe. High moisture levels block air flow paths (i.e., reduced air porosity) and prevent direct contact with contaminants. Contaminants which dissolve into the aqueous phase are also slower and more difficult to remove by SVE.

BIOVENTING TREATABILITY STUDY

A bioventing bench-scale treatability study was performed by Envirogen Inc. (Envirogen) on a reasonable worst case contaminated soil sample from the Off-Site Containment Area. The study included a nutrient amended column (i.e., bioventing), a non-amended column (i.e., SVE only), and an azide control (i.e., reduced biological activity SVE column). Approximately 3,000 air pore volumes were passed through the columns. The samples were analyzed for VOCs and SVOCs before and after the column studies. A detailed summary is provided below.

- Based on a comparison of the results for the control (i.e., azide) column versus the non-amended and nutrient amended columns, nutrient enhancement significantly increased the removal efficiencies for the SVOCs and moderately increased the removal efficiencies for the ETX compounds. The results of the bioventing tests demonstrate that most of the target non-chlorinated VOC and SVOC contaminants are subject to removal by biological degradation to varying degrees.
- Even though significant SVOC reductions occurred under enhanced bioventing conditions (i.e., nutrient enhanced column), SVOCs which were detected in excess of their respective remediation levels were not reduced to below the remediation levels. Isophorone and bis(2-ethylhexyl)phthalate had final concentrations in excess of their remediation levels in the nutrient enhanced column.
- The SVOC removal efficiencies were greater for the SVE treatability tests than for the analogous non-amended bioventing treatability test. This is likely due either to the higher mass of oxygen which was delivered during the SVE treatability tests (i.e., approximately 11,000 versus 3,000 air pore volumes) or analytical variances caused by the sampling of a potentially non-homogenous soil matrix.
- It appears that a significant portion of the acetone, 2-butanone, 4-methyl-2-pentanone, benzene, ethyl benzene, xylene, and toluene reductions can be attributed to biological degradation. This conclusion

is based on the mass balance calculations performed for the SVE treatability tests (i.e., a significant portion of the VOC mass cannot be accounted for by the exhaust gas measurements), as well as a comparison of the exhaust gas measurements for the SVE and bioventing treatability tests (i.e., the individual contaminant concentrations measured in the exhaust gas for the bioventing tests were lower).

- The initial concentrations for the VOCs and SVOCs were equivalent to those found in the SVE treatability test samples and can be considered representative of the weighted average concentrations for the Off-Site Area, but are not representative of localized maximum concentrations measured during the RI.
- The site conditions appear to be capable of supporting enhanced biological activity.

The following factors associated with the effectiveness and operation of a full-scale bioventing system could not be evaluated as part of a bench-scale treatability study. These conditions will likely have to be evaluated during the RD/RA phases of this project.

- Slower removal rates and higher final concentrations are usually observed for full-scale SVE and bioventing systems when compared against bench-scale treatability studies. Bench-scale SVE and bioventing tests represent optimum, best case conditions where there is direct and continuous contact of air and nutrients with the contaminants. These conditions are usually not uniformly achievable throughout the entire treatment zone for full-scale systems. Subsurface geologic heterogeneities and obstructions and nutrient transport mechanisms usually impact the ability to uniformly deliver oxygen and nutrients to all areas and depths of the treatment zone.
- The feasibility and cost effectiveness of various in-situ nutrient delivery systems would have to be evaluated. Surface spraying/irrigation and infiltration galleries are the primary methods of delivering nutrients to the unsaturated zone. The ability to effectively deliver nutrients to the unsaturated zone is typically limited to a relatively small and shallow source area.

MSR/rca/
[CHI 104 94]



February 10, 1993

Mr. Wayde Hartwick
Remedial Project Manager (HSRL-6J)
United States Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

Re: Proposed Modifications to Soil Clean-up Levels
American Chemical Service Superfund Site
Griffith, Indiana

Dear Mr. Hartwick:

Representatives of the American Chemical Service (ACS) Potentially Responsible Parties (PRPs) Technical Committee (Warzyn Inc., Conestoga Rovers & Associates, and Dr. Frank Mink) met with representatives of the Environmental Protection Agency on December 16, 1992 to discuss the appropriateness of the soil cleanup levels established in the Record of Decision (ROD) issued September 30, 1992. The PRP representatives explained that the cleanup levels established in the ROD were inconsistent with governing United States Environmental Protection Agency (U.S. EPA) guidance in effect at the time the U.S. EPA and its oversight contractor, Roy F. Weston, Inc., had developed them.

At the December 16 meeting, a U.S. EPA's toxicologist, Ms. Patricia Van Leeuwen, asked Warzyn to submit for the U.S. EPA's review and consideration: (1) a discussion of the requirements in the governing guidance which were not followed by Weston and the U.S. EPA in the development of cleanup levels; and (2) the modifications which would be required to the methodology for calculating cleanup levels to make it conform with the applicable guidance. This letter responds to that request.

As noted by the U.S. EPA in its ROD, cleanup levels for this site were developed by the U.S. EPA and Weston well after Warzyn had completed the Baseline Risk Assessment (BIRA). In fact, the cleanup levels were not developed nor presented as part of the U.S. EPA's Proposed Plan for remediation for public comment, but were only finalized shortly prior to ROD issuance. The cleanup levels were developed without consideration of two applicable guidance documents: (1) Dermal Exposure Assessment: Principles and Applications (Jan. 1992) (DEA); and (2) Risk Assessment Guidance for Superfund: Volume 1 - Human

THE PERFECT BALANCE
BETWEEN TECHNOLOGY
AND CREATIVITY

CHICAGO
2100 CORPORATE DRIVE
ADDISON, IL 60101
708/691-5000
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Health Evaluation Manual (Part B, Development of Risked-based Preliminary Remediation Goals) (Dec. 1991) (RAGS-Part B).

Failure to follow applicable guidance has resulted in incorrect calculation of cleanup levels respecting:

1. Dermal route of exposure - dermal absorption estimates, soil adherence factor, and skin surface area available for contact
2. Toxicity values
3. Shallow vs. deep soil exposure routes

These calculations can be corrected without delay of the U.S. EPA's schedule for implementing the Remedial Design/Remedial Action (RD/RA). Further, because the B1RA was completed in accordance with the then existing guidance and served its intended purpose of developing remedial alternatives and selecting a remedy, the cleanup levels for ACS can be revised without requiring alteration to the B1RA or to the Remedial Investigation/Feasibility Study.

In the attachment, Warzyn discusses modifications to the methodology for calculating cleanup levels which need to be made so that cleanup levels consistent with the guidance can be established. Warzyn will proceed to calculate the soil cleanup levels consistent with the guidance following your review of this submittal and your agreement that the suggested modifications correctly apply U.S. EPA guidance and comport with the National Contingency Plan.

Should you have questions or comments, or should you believe a meeting is appropriate, please do not hesitate to call Mr. Hamper at (708) 691-5065.

Sincerely,

WARZYN INC.

Martin J. Hamper
Project Manager

Michael W. Kierski, Ph D
Toxicologist

Enclosure: Attachment 1

cc: ACS Technical Committee
Mr. R. Frehner
Mr. F. Mink

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[CHI 606 87]
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ATTACHMENT 1

PROPOSED MODIFICATIONS TO THE ROD IMPOSED CLEANUP LEVELS FOR THE ACS SITE

INTRODUCTION

The purpose of this document is to identify and discuss proposed modifications to the American Chemical Service (ACS) soil cleanup levels established in the Record of Decision (ROD). These modifications are warranted because the ACS site cleanup levels calculated Roy F. Weston Inc. (Weston) on behalf of the United States Environmental Protection Agency (U.S. EPA) without benefit of public comment are not consistent with applicable U.S. EPA guidance.

Specifically, Weston did not use the Dermal Exposure Assessment: Principles and Applications (DEA) guidance manual published by the U.S. EPA in January 1992, and Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part B. Development of Risk-based Preliminary Remediation Goals) (RAGS - Part B) guidance manual published by the U.S. EPA in December 1991. The final remediation levels developed by Weston were simply back-calculated from the residential future use scenario from the BIRA, and did not incorporate new information included in the available guidance manuals.

BACKGROUND

The U.S. EPA issued significant new Superfund guidance in December 1991, and January 1992. The FS was completed in June 1992, without numerical cleanup levels. The Proposed Plan for the ACS site was issued on June 25, 1992, and it indicated that the site would have to be remediated to meet health-based levels.

However, the Proposed Plan did not contain proposed cleanup levels and the only reference in the Administrative Record (AR) was document #203, which provided no explanation as to what standards would ultimately apply, or the method by which they were calculated.¹ The U.S. EPA had tasked Weston to develop health-based cleanup levels for the ACS site, and Weston continued to refine the cleanup levels until the Record of Decision (ROD) was issued in September 1992 (see Update #1 AR, Documents #23 and #25). Warzyn has now learned that the final remediation levels established in the ROD were simply back-calculated from the on-site residential future use scenario presented in the ACS Baseline Risk Assessment (BIRA).

REQUESTED MODIFICATIONS TO THE CLEANUP LEVEL CALCULATION APPROACH

This section describes the proposed methods and exposure parameters to be updated and modify the soil cleanup levels imposed in the ACS ROD. The following are the key modifications which are required to set soil cleanup levels consistent with applicable guidance:

- Update the dermal route of exposure characterization by modifying the dermal absorption factors, soil-to skin adherence factor, and skin surface area available for soil contact based upon the DEA
- Update toxicity values (reference doses, and slope factors) to account for recent information on the toxic potency of particular chemicals based upon the U.S. EPA's data base
- Utilize the U.S. EPA's Relative Potency Factors (RPFs) to account for the varying carcinogenic potential of specific polycyclic aromatic hydrocarbons (PAHs)
- Calculate soil cleanup separately for surface and subsurface soils utilizing the conditions post-remediation based upon RAGS - Part B
- Calculate the risk based soil cleanup values using the methods and equations provided in RAGS - Part B
- Evaluate risk-based soil cleanup levels for technical limitations due to analytical quantitation limits as outlined in RAGS - Part B

¹ For additional discussion see "Comments on the Proposed Plan for Remedial Action, American Chemical Service National Priorities List Site, Griffith, Indiana, August 1992, prepared by Warzyn Inc. for the ACS Steering Committee Organizational Group.

The following is a detailed discussion on each of the modifications listed above.

Dermal Route Of Exposure

For purposes of the B1RA, characterization of the dermal route of exposure followed U.S. EPA's direction and its exercise of best professional judgment. Finalization of the B1RA preceded issuance of DEA by about four months, which became available in January 1992. This manual modified the U.S. EPA's approach to characterizing the dermal route of exposure. This modified approach could have and should have been used in calculating soil cleanup levels since it was available at the time those levels were determined. Given the nature and purpose of the B1RA, issuance of the DEA does not obligate that it be redone; however, the current approach should have been used to set cleanup standards utilizing the underlying data on which the B1RA was developed.

In comparing the factors used to characterize the dermal route of exposure in the ACS B1RA, and the information in the DEA, there are three key factors established in the guidance which should have been updated to calculate cleanup levels for the ACS site. These three factors are:

- The soil-to-skin-adherence factor (AF)
- The skin surface area available for soil contact (SA)
- The dermal absorption values (ABS)

The following is a summary of the values used in the ACS B1RA, and the more applicable values based on the DEA.

Dermal Exposure Factor	B1RA Value	DEA Derived Value
Skin SA	8.620 cm ²	5.800 cm ²
AF	2.11 mg/cm ²	0.2 mg/cm ²

% Dermal Absorption

VOCs	30%	0.3%
Other Organics	30%	0.6%
Inorganics	1%	0.1%

The following is a discussion of how each of the dermal exposure values were

developed based on the information presented in the DEA.

Revised Soil to Skin Adherence Factor - The skin adherence factor (AF) used in the ACS BIRA was based upon an average of two values in RAGS-Part A, which was the best information available at the time. The DEA supersedes this value, and provides a range of standard values for the soil to skin adherence factors (AF) (refer to Table 8-6 on page 8-20 of the DEA). Based on the data presented in the DEA and the sandy texture of the soil at the ACS site, an AF of 0.2 mg/cm² is appropriate.

Revised Skin Surface Area Available for Soil Contact - The DEA provides updated standard values for the amount of skin which may be available for soil contact (refer to Table 8-6 on page 8-20 of the DEA). The DEA guidance value for surface area of 5,800 cm² is appropriate in calculating ACS soil cleanup levels.

Revised Dermal Absorption Estimates - The DEA provides an updated approach to determining dermal absorption estimates superseding the "default" values employed at the time the ACS BIRA was developed. The updated DEA approach should be used to determine dermal absorption estimates. Appendix A provides for a detailed discussion of the development of proposed dermal absorption estimates based on information provided in the DEA.

Update Of Toxicity Values

The ACS ROD established clean-up levels without considering current information in the U.S. EPA's Integrated Risk Information System (IRIS), or secondary data bases. Certain toxicity factors (i.e., reference doses and slope factors) have been updated, withdrawn or added to the IRIS and secondary data bases since the BIRA was completed. Because the toxicity factors have a large impact on the magnitude of the soil cleanup levels, the most current toxicity values should have been used when developing the ACS soil cleanup levels. The toxicity values should have been obtained from the following sources in order of their importance:

- Integrated Risk Information System (IRIS)
- Health Effects Assessment Summary Table (HEAST)
- The Environmental Criteria and Assessment Office (ECAO)

In the past, the slope factor for benzo(a)pyrene (B(a)P) has been used to represent the carcinogenic potential of all carcinogenic PAHs. Each carcinogenic PAH does not have the same cancer potency as B(a)P; in fact, most other carcinogenic PAHs are much less carcinogenic than B(a)P. For this reason, it is no longer

considered appropriate to use the same slope factor (i.e., B(a)P) to calculate the soil cleanup values for each carcinogenic PAH. Instead, relative potency factors (RPF), which relate the cancer potency of a PAH to the cancer potency of B(a)P (U.S. EPA 1988), are being used by the U.S. EPA to calculate more accurate slope factors for carcinogenic PAHs. In fact, at the time the U.S. EPA calculated the cleanup levels for the ACS site, Region V was using the RPF approach as "best professional judgment" at other CERCLA sites, but did not use this approach for ACS. The following are the RPFs for each carcinogenic PAH.

<u>PAH</u>	<u>Relative Potency Factor</u>
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.07
Dibenz(ah)anthracene	1.0
Chrysene	0.004
Indeno(1,2,3-cd)pyrene	0.2

The RPF for each carcinogenic PAH is multiplied by B(a)P's slope factor to calculate the carcinogenic PAHs slope factor. This approach should be used in the calculation of the ACS soil cleanup values.

Calculation of Cleanup Values Separately for Surficial and Subsurface Soil

Soil cleanup levels should have been calculated separately for the surficial soils and subsurface soils (i.e., a tiered approach), based on RAGS - Part A. The ACS BIRA made distinctions between surficial vs subsurface soils, where appropriate, but the concept was not included when Weston prepared the soil cleanup levels for the ACS site.

People generally have little potential to be directly exposed to subsurface soils due to such soils being buried at depth. (Subsurface soils would be below the soil zone potentially disturbed during residential construction.) Because the populations exposed are different for surficial soils and subsurface soils due to the burial of subsurface soils, soil cleanup values for both surficial and subsurface soil should have been developed.

Subsurface soils may pose a human exposure concern if they are encountered during an excavation. General excavation of soils post-remediation would be prohibited by deed restrictions and institutional controls. If it were to occur, it would take place in isolated areas for limited activities such as for utility repairs (with appropriate protective gear). In any event, construction workers would be

the population potentially exposed.² For this reason, subsurface soil cleanup levels should be developed for a construction worker scenario to realistically address potential future exposure scenarios.

Equations to be Used to Calculate the Soil Cleanup Levels

The revisions outlined above should have been used by the U.S. EPA in developing cleanup levels. Because the U.S. EPA's levels and methodology were not set forth in the Proposed Plan, and the levels appeared only in the ROD, this is Warzyn's and the PRP's first opportunity to provide meaningful comment. The simple proportioning approach used by the U.S. EPA and Weston utilized the concentration of the chemical in soil (i.e., the exposure point concentration) and the resultant risk calculated in the ACS BIRA to determine the soil cleanup level at a specific risk level.

Table 1 provides the soil cleanup equation from RAGS - Part B for a residential future use scenario. Although the dermal route of exposure is not included in the U.S. EPA's standard equation within RAGS - Part B, the equation has been modified by Warzyn to be more conservative by including the dermal route of exposure. This equation can be used to calculate ACS soil cleanup levels. Modified exposure factors (e.g., dermal absorption values, skin surface area, etc.), and toxicity factors identified previously in this correspondence also should be utilized with all other required exposure factors obtained from the ACS BIRA.

Comparison of Risk-Based Soil Cleanup Levels to Chemical Quantitation Limits

Consistent with RAGS - Part B, analytical limitations should be considered when developing the final soil cleanup levels (refer to page 17, Section 2.8.3). Weston provided soil cleanup levels that are below concentrations that can be detected with a reasonable level of certainty (i.e., quantitation limit). The cleanup levels should have been elevated to the practical quantitation limit (PQL) to account for both laboratory and technological limitations. In calculating modified soil cleanup levels based upon current U.S. EPA guidance, no cleanup level should be set below the PQL. (See 55 FR 22520, at page 22540, June 1, 1990.)

²As you know from past discussions, the PRP group and its representatives believe that the RI/FS and applicable guidance warrant an industrial use scenario. Argument in support of that position will not be presented here, as the U.S. EPA has advised it will not reassess the appropriateness of the residential future use scenario. Nothing stated herein shall constitute a waiver of any PRP's right to challenge the U.S. EPA's selected residential future use scenario.

SUMMARY

On the behalf of the ACS PRPs, Warzyn requests that the ACS soil cleanup levels be modified to take into account U.S. EPA guidance available at the time of their preparation. The key modifications are:

- Update the dermal route of exposure characterization by modifying the dermal absorption factors, soil-to skin adherence factor, and skin surface area available for soil contact based upon the DEA
- Update toxicity values (reference doses, and slope factors) to account for recent information on the toxic potency of particular chemicals based upon the U.S. EPA's IRIS database, and secondary data bases.
- Utilize the U.S. EPA's Relative Potency Factors (RPFs) to account for the varying carcinogenic potential of specific polycyclic aromatic hydrocarbons (PAHs)
- Calculate soil cleanup separately for surface and subsurface soils utilizing the conditions post-remediation based upon RAGS - Part B
- Calculate the risk based soil cleanup values using the methods and equations provided in RAGS - Part B
- Evaluate risk-based soil cleanup levels for technical limitations due to analytical quantitation limits as outlined in RAGS - Part B

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TABLE 1

Equations Proposed to
Calculate Remedial Levels (RLs)
American Chemical Service Site

Soil Exposure
(via Oral and Dermal Routes)

Carcinogenic Effects

$$C \text{ (mg/kg)} = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times [(SFO \times 10^{-6} \text{ kg/mg} \times IR \text{ soils}) + (1/SFd \times 10^{-6} \text{ kg/mg} \times AF \times ABS \times SA \text{ soil})]}$$

Noncarcinogenic Effects

$$C \text{ (mg/kg)} = \frac{THI \times BW \times AT \times 365 \text{ days/year}}{ED \times EF \times [(1/RfDo \times 10^{-6} \text{ kg/kg} \times IR \text{ soil}) + (1/RfDd \times 10^{-6} \text{ kg/kg} \times AF \times ABS \times SA \text{ soil})]}$$

NOTES:

C	=	Chemical concentration in medium (i.e., mg/kg - soil and sediment and mg/L - surface water)
TR	=	Target excess individual lifetime cancer risk (unitless)
THI	=	Target hazard index (unitless)
SFO	=	Oral cancer slope factor (mg/kg-day) ⁻¹
SFd	=	Dermal cancer slope factor (mg/kg-day) ⁻¹
RfDo	=	Oral reference dose (mg/kg/day)
RfDd	=	Dermal reference dose (mg/kg/day)
BW	=	Body weight (kg)
AT	=	Average time (year(s))
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (year(s))
IR soil	=	Soil ingestion rate (mg/day)
AF	=	Soil to skin adherence factor (mg/cm ²)
ABS	=	Dermal adsorption factor (unitless)
SA soil	=	Skin surface area available for contact with soil (cm ² /event)

APPENDIX A

DEVELOPMENT OF DERMAL ABSORPTION ESTIMATES

INTRODUCTION

The following is a discussion of the dermal absorption estimates utilized in the American Chemical Services (ACS) Baseline Risk Assessment (BIRA) in comparison to the guidance provided in the Dermal Exposure Assessment: Principles and Applications (DEA) guidance manual. In addition, a discussion of the basis for the proposed dermal absorption estimates based upon the DEA guidance manual is provided.

Within the BIRA two default dermal absorption estimates were used. A default value of 30% was assumed for all organic chemicals, and 1% was assumed for all inorganic analytes. These default values were used at the insistence of the United States Environmental Protection Agency (U.S. EPA) exercising its "best professional judgment" at the time. After the BIRA was finalized, the U.S. EPA rejected the approach in favor of the procedure established by the DEA guidance. Although the DEA guidance manual was available when Weston was calculating the soil clean-up levels, Weston did not utilize the guidance.

U.S. EPA APPROACH BASED ON THE DEA GUIDANCE DOCUMENT

Within the DEA manual, U.S. EPA provided recommended dermal absorption values information for three chemicals: dioxins, polychlorinated-biphenyls (PCBs) and cadmium. At the ACS site, risk based clean-up levels are not required for the two of the three chemicals which have U.S. EPA recommended dermal absorption values. There are no U.S. EPA recommended dermal absorption estimates for the other chemicals detected on-site. As is normally done

when no values are available, however, the risk associated with dermal exposure is either addressed qualitatively or derived dermal absorption values are developed based on the best available dermal absorption data.

Because no U.S EPA approved dermal absorption estimates exist for most chemicals at the ACS site, realistic derived dermal absorption estimates have been developed based on the information provided in the DEA manual. Derived dermal absorption estimates were developed for volatile organic compounds (VOCs), other organics, and inorganics. The development of these derived values is discussed in the following section.

APPROACH USED FOR DEVELOPING THE DERMAL ABSORPTION VALUES

The DEA manual supports the conclusion that dermal absorption estimates should be derived:

- Based on human rather than rat experimental data
- Based on a standard soil contact time on skin
- Based on data where the soil on skin was not occluded

The data presented in the DEA indicate that the rate of absorption of compounds varied from species to species. It was stated in the DEA manual that rat skin is approximately three times more permeable than human skin (DEA, page 6-6). This fact was illustrated by the data presented for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and 3,3',4,4'-tetrachlorobiphenyl (TCB) in the DEA as well. For this reason, dermal absorption values were derived using human data rather than rat data presented in the DEA.

In addition, within the DEA, Section 8.3.1, the soil contact time is discussed. Based on studies by Hawley (1985), soil exposure times were assumed to be between 12 hours/day for young children to 8 hours/day for adults. The soil exposure time represents the time between soil exposure (contact/adherence) and the time the contacted soil is washed from the skin. The longer the soil is in contact with the skin, the higher is the percent dermal absorption of the chemical. On page 8-5 of the DEA it states:

No actual data could be found on the residence times of soil residues on skin. It probably corresponds to the time between washings or about 8 to 24 hours. Since the residence times of soil residues on skin are probably in the range of 8 to 24 hours, experiments conducted over similar times provide the best basis for percent absorption estimates.

Twelve hours was assumed to be a reasonable amount of time between contacting soil and washing for children. The percent dermal absorption estimate for a 12 hour residence time was applied based on the work of Hawley (1985), where sufficient data was available for non-occluded skin.

It is commonly known that occluding (covering) the skin does not provide for volatilization of a chemical, and artificially increases the dermal absorption of volatile compounds. For this reason, Warzyn used dermal absorption experiments where the skin was not occluded to develop the default dermal absorption estimates.

DATA USED TO DEVELOP DEFAULT DERMAL ABSORPTION ESTIMATES

The following are the surrogate chemicals selected to represent the chemical groups, the derived dermal absorption estimate, and a short discussion of the data used to arrive at the dermal absorption estimates. Refer to Tables A-1 and A-2 for a presentation of the data used from the DEA to predict the values for TCB, and TCDD.

<u>Chemical Group</u>	<u>Indicator Chemical</u>	<u>% Dermal Absorption</u>
Volatile Organics	Hexadecane	0.3
Other Organics	TCDD and TCB	0.6
Metals	Cadmium	0.1

Volatile Organic Compounds

Based on the U.S. EPA's review of the available literature in the DEA manual, a single study has been conducted with a volatile solvent (i.e., hexadecane) where the skin has not been occluded. Kissel and Duff (1991) using human skin found that after 24 hrs. 91% of the solvent had volatilized from the skin surface, 8% was retained on the soil, and 0-0.3% of the hexadecane had been absorbed. Because hexadecane is a less volatile solvent than the VOCs detected at the site, the 0.3% dermal absorption estimate is considered a reasonable dermal absorption estimate for the VOCs detected at the site.

Other Organic Compounds

Based on the U.S. EPA's review in the DEA manual of studies conducted on dermal absorption of soil-bound contaminants, the data for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and 3,3',4,4'-tetrachlorobiphenyl (TCB), which is a PCB congener, was considered most reliable based on the quality of the research. Based on data provided by the U.S. EPA in the DEA for

dermal absorption of TCDD or TCB through human skin, an absorption estimate of 0.1% and 0.6% were estimated for a 12 hr soil contact event for each chemical, respectively. The highest absorption estimate was selected as the default value to be conservative. The soil used in each study was a low organic matter content soil. Dermal absorption was found to be lower for soils with higher organic matter content. Therefore, the 0.6% dermal absorption estimate was considered a conservative estimate to be applied at the soils at the site (i.e., low organic content). In addition, based on Weston's soil clean-up values, PAHs, and pesticides were determined to be the main organic compounds with extremely low clean-up values. Based on the similar absorption potential of the TCDD, and TCB to soil as PAHs and pesticides, these data were considered more relevant for developing soil clean-up levels.

Inorganics

Data on the dermal absorption of cadmium from soil was used to represent the dermal absorption of inorganic contaminants from soil. Wester et al. (1991) utilized cadmium adsorbed to soil with human skin to estimate the percentage of absorption of cadmium after 16 hrs of exposure. The average absorption for twelve samples was 0.1%. Based on the fact that cadmium is known to bind to soils less readily than many other heavy metals, such as lead, this estimate was considered to be a reasonable dermal absorption estimate for metals from soils. For example, the dermal absorption of a water soluble lead salt was determined by Moore et al. (1980) using human subjects to be 0.1%. Considering lead's high ability to be bound to soil, the amount of lead absorbed by the dermal route from soil would be expected to be much less than 0.1%.

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TABLE A-1

**Calculation of Dermal Absorption Estimate
Based on Human Data - TCB**

<u>Time (Hour)</u>	<u>% TCB Absorption</u>
*0	0.00
1	0.00
2	0.00
4	0.00
8	0.00
*24	1.07
*48	3.18
*72	5.26
*96	7.10

Linear Regression Line: $y = 7.66 \times 10^{-2} x - 0.356$ $r=0.995$

If $x=12$ hours, $y = 0.6\%$ absorbed dermally

LEGEND:

TCB = 3,3', 4,4' - Tetrachlorobiphenyl
 x = Number of hours soil had been in contact with skin
 y = percentage (%) of TCB dermal absorption from soil
 r = Correlation coefficient for line of regression. A value of 1 indicates a perfect line of fit to the general equation $y = mx+b$ where:
 m - slope of line
 b - y intercept of line
 x and y - as defined above

NOTES:

The data presented within this table was obtained from Dermal Exposure Assessment: Principles and Applications (U.S. EPA 1992) provided on page 6-21. The data presented is for in-vitro dermal absorption studies conducted with human skin samples. The soil application rate to skin was 6 mg/cm² of a low organic content soil.

A linear regression line was calculated using each of the data points where some absorption was measurable (i.e., points denoted with an asterisk). In addition, a (zero,zero) data point was factored into the regression data set as a lower bound. The line of regression equation was used to predict the percentage of dermal absorption of TCB (i.e., 0.6%) after 12 hours of soil contact with the skin.

TABLE A-2

**Calculation of Dermal Absorption Estimate
Based on Human Data - TCDD**

<u>Time (Hour)</u>	<u>% TCDD Absorption</u>
*0	0.00
1	0.02
2	0.08
4	0.07
8	0.02
*24	0.28
*48	0.91
*72	1.54
*96	2.25

Linear Regression Line: $y = 2.4 \times 10^{-2} x - 0.16$ $r=0.991$

If $x=12$ hours, $y = 0.1\%$ absorbed dermally

LEGEND:

TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin
 x = Number of hours soil had been in contact with skin
 y = percentage (%) of TCDD dermal absorption from soil
 r = Correlation coefficient for line of regression. A value of 1 indicates a perfect line of fit to the general equation $y = mx+b$ where:
 m - slope of line
 b - y intercept of line
 x and y - as defined above

NOTES:

The data presented within this table was obtained from Dermal Exposure Assessment: Principles and Applications (U.S. EPA 1992) provided on page 6-17. The data presented is for in-vitro dermal absorption studies conducted with human skin samples. The soil application rate to skin was 6 mg/cm² of a low organic content soil.

A linear regression line was calculated using each of the data points where the amount of absorption consistently increased with time (i.e., points denoted with an asterisk). In addition, a (zero,zero) data point was factored into the regression data set as a lower bound. The line of regression equation was used to predict the percentage of dermal absorption of TCDD (i.e., 0.1%) after 12 hours of soil contact with the skin.

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